

What is claimed is:

1. An automatic brake system for a vehicle comprising:
a forward-monitoring unit that automatically detects an obstacle
preceding the vehicle; and
5 a control unit that executes an automatic braking control operation to
avoid a potential collision with the obstacle, based on a steering
characteristics of the vehicle.
2. The automatic brake system as claimed in claim 1, wherein:
10 the steering characteristics includes at least one of a steering
characteristics dependent on manual steering operation and a
steering characteristics dependent on a state of the vehicle.
3. The automatic brake system as claimed in claim 1, wherein:
15 the control unit determines the steering characteristics, based on a
condition of a path where the vehicle is traveling.
4. The automatic brake system as claimed in claim 1, wherein:
the control unit comprises:
20 a steering characteristics determining unit that determines the
steering characteristics;
a steering-based avoidance determining unit that determines a
possibility that the vehicle can avoid the potential collision with
the obstacle by steering, passing on either side of left and right
25 sides of the obstacle, based on the steering characteristics
determined by the steering characteristics determining unit;
a brake-based avoidance determining unit that determines a
possibility that the vehicle can avoid the potential collision with
the obstacle by braking; and

an automatic brake control determining unit that executes the automatic braking control operation to avoid the potential collision with the obstacle, based on the possibility determined by the steering-based avoidance determining unit and the possibility
5 determined by the brake-based avoidance determining unit.

5. The automatic brake system as claimed in claim 4, wherein:
the control unit further comprises an avoidance space width detecting unit that detects widths of spaces on the sides of the obstacle; and
10 the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the widths of the spaces on the sides of the obstacle.

15 6. The automatic brake system as claimed in claim 5, wherein:
the control unit further comprises a steering-based avoidance easiness determining unit that determines a degree of easiness with which the vehicle can avoid the potential collision with the obstacle by steering, based on the widths of the spaces on the sides of the
20 obstacle and a width of the vehicle; and
the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the degree of easiness.

25 7. The automatic brake system as claimed in claim 4, wherein:
the control unit further comprises a lateral displacement calculating unit that determines a lateral displacement required for a steering-based collision avoidance to each of the sides of the obstacle, based on a condition of a path where the vehicle is
30 traveling detected by the forward-monitoring unit; and

the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the lateral displacements detected by the lateral displacement calculating unit.

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8. The automatic brake system as claimed in claim 7, wherein:
the control unit further comprises:

an avoidance space width detecting unit that detects widths of spaces on the sides of the obstacle; and

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a steering-based avoidance easiness determining unit that determines a degree of easiness with which the vehicle can avoid the potential collision with the obstacle by steering, based on the widths of the spaces on the sides of the obstacle and a width of the vehicle;

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the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the degree of easiness with which the vehicle can avoid the potential collision with the obstacle by steering determined by the steering-based avoidance easiness determining unit; and

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the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the lateral displacements detected by the lateral displacement calculating unit, only when the possibility that the vehicle can avoid the potential collision with the obstacle by steering determined by the steering-based avoidance determining unit is positive for both sides of the obstacle.

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9. The automatic brake system as claimed in claim 8, wherein:

the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, only for a side of the obstacle where the lateral displacement detected by the lateral displacement calculating unit is smaller than on another side.

10. An automatic brake system for a vehicle comprising:
forward-monitoring means for automatically detecting an obstacle preceding the vehicle; and
10 control means for executing an automatic braking control operation to avoid a potential collision with the obstacle, based on a steering characteristics of the vehicle.

11. A method of controlling a braking operation of a vehicle, the method comprising:
15 automatically detecting an obstacle preceding the vehicle; and
executing an automatic braking control operation to avoid a potential collision with the obstacle based on a steering characteristics of the vehicle, when the obstacle is detected.

20 12. An automatic brake system for a vehicle comprising:
a forward-monitoring unit that automatically detects an obstacle preceding the vehicle, and a geometrical relationship among the vehicle, the obstacle and a path where the vehicle is traveling;
25 a control unit that executes an automatic braking control operation to avoid a potential collision with the obstacle, based on a steering characteristics of the vehicle and the geometrical relationship; and
a brake control unit that generates a braking force according to the automatic braking control operation determined by the control unit.

13. The automatic brake system as claimed in claim 12, wherein:
the control unit determines the automatic braking control operation,
based on the steering characteristics which includes at least one of
a steering characteristics dependent on manual steering operation
5 and a steering characteristics dependent on a state of the vehicle.

14. The automatic brake system as claimed in claim 13, wherein:
the control unit comprises a steering characteristics determining unit
that determines the steering characteristics dependent on manual
steering operation, based on a degree of easiness with which the
10 vehicle can avoid the potential collision with the obstacle by
steering.

15. The automatic brake system as claimed in claim 14, wherein:
the steering characteristics determining unit determines the steering
characteristics dependent on manual steering operation as with
which a maximum steering angle is larger and a steering speed is
faster, when the degree of easiness is higher; and
the steering characteristics determining unit determines the steering
20 characteristics dependent on manual steering operation as with
which a maximum steering angle is smaller and a steering speed is
slower, when the degree of easiness is lower.

16. The automatic brake system as claimed in claim 14, wherein:
25 the control unit further comprises a steering-based avoidance
easiness determining unit that determines the degree of easiness
with which the vehicle can avoid the potential collision with the
obstacle by steering, based on widths of spaces on sides of the
obstacle and a width of the vehicle.

17. The automatic brake system as claimed in claim 13, wherein:
the control unit determines the steering characteristics dependent on
a state of the vehicle, based on at least one of a vehicle weight, a
yaw moment of inertia, a vehicle speed, a yaw rate, a vehicle slip
5 angle, a distance between a center of mass of the vehicle and a
front axle, a distance between the center of mass of the vehicle and
a rear axle, a lateral force acted by the front wheels, and a lateral
force acted by the rear wheels.
- 10 18. The automatic brake system as claimed in claim 12, wherein:
the control unit determines the steering characteristics, based on a
condition of the path where the vehicle is traveling.
- 15 19. The automatic brake system as claimed in claim 12, wherein:
the control unit comprises:
a steering characteristics determining unit that determines the
steering characteristics;
a steering-based avoidance determining unit that determines a
possibility that the vehicle can avoid the potential collision with
20 the obstacle by steering, passing on sides of the obstacle, based
on the steering characteristics determined by the steering
characteristics determining unit; and
an automatic brake control determining unit that determines the
automatic braking control operation to avoid the potential
25 collision with the obstacle, based on the possibility determined by
the steering-based avoidance determining unit.
20. The automatic brake system as claimed in claim 12, wherein:
the control unit comprises:

a steering characteristics determining unit that determines the steering characteristics;

a steering-based avoidance determining unit that determines a possibility that the vehicle can avoid the potential collision with the obstacle by steering, passing on either one of left and right sides of the obstacle, based on the steering characteristics determined by the steering characteristics determining unit;

a brake-based avoidance determining unit that determines a possibility that the vehicle can avoid the potential collision with the obstacle by braking, based on the geometrical relationship; and

an automatic brake control determining unit that determines the automatic braking control operation to avoid the potential collision with the obstacle, based on the possibility determined by the steering-based avoidance determining unit and the possibility determined by the brake-based avoidance determining unit.

21. The automatic brake system as claimed in claim 20, wherein: the automatic brake control determining unit determines to operate the braking force when the possibility determined by the steering-based avoidance determining unit and the possibility determined by the brake-based avoidance determining unit are both positive.

22. The automatic brake system as claimed in claim 20, wherein: the control unit further comprises an avoidance space width detecting unit that detects widths of spaces on the sides of the obstacle; and the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the

obstacle by steering, based on the widths of the spaces on the sides of the obstacle.

23. The automatic brake system as claimed in claim 22, wherein:

5 the control unit further comprises a steering-based avoidance easiness determining unit that determines a degree of easiness with which the vehicle can avoid the potential collision with the obstacle by steering, based on the widths of the spaces on the sides of the obstacle and a width of the vehicle; and

10 the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the degree of easiness.

24. The automatic brake system as claimed in claim 20, wherein:

15 the control unit further comprises a lateral displacement calculating unit that determines a lateral displacement required for a steering-based collision avoidance to each of the sides of the obstacle, based on a condition of the path where the vehicle is traveling detected by the forward-monitoring unit; and

20 the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the lateral displacements detected by the lateral displacement calculating unit.

25 25. The automatic brake system as claimed in claim 24, wherein:
the control unit further comprises:

an avoidance space width detecting unit that detects widths of spaces on the sides of the obstacle; and

30 a steering-based avoidance easiness determining unit that determines a degree of easiness with which the vehicle can avoid

the potential collision with the obstacle by steering, based on the widths of the spaces on the sides of the obstacle and a width of the vehicle;

- 5 the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the degree of easiness with which the vehicle can avoid the potential collision with the obstacle by steering determined by the steering-based avoidance easiness determining unit; and
- 10 the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the lateral displacements detected by the lateral displacement calculating unit, only when the possibility that the vehicle can avoid the potential collision with the
- 15 obstacle by steering determined by the steering-based avoidance determining unit is positive for both sides of the obstacle.

26. The automatic brake system as claimed in claim 25, wherein:
- 20 the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, only for a side of the obstacle where the lateral displacement detected by the lateral displacement calculating unit is smaller than on another side.

- 25 27. The automatic brake system as claimed in claim 20, wherein:
- the control unit further comprises a lateral displacement calculating unit that determines a lateral displacement required for a steering-based collision avoidance to each side of the obstacle, based on a condition of the path where the vehicle is traveling
- 30 detected by the forward-monitoring unit;

the steering-based avoidance determining unit determines a required time for the lateral displacement, based on a condition of the path where the vehicle is traveling detected by the forward-monitoring unit; and

- 5 the steering-based avoidance determining unit determines the possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the required time for the lateral displacement, a longitudinal distance between the vehicle and the obstacle, and a relative speed of the vehicle to the obstacle.

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28. An automatic brake system for a vehicle comprising:

forward-monitoring means for automatically detecting an obstacle preceding the vehicle, and a geometrical relationship among the vehicle, the obstacle and a path where the vehicle is traveling;

- 15 control means for executing an automatic braking control operation to avoid a potential collision with the obstacle, based on a steering characteristics of the vehicle and the geometrical relationship; and
brake control means for generating a braking force according to the automatic braking control operation determined by the control
20 means.

29. A method of controlling a braking operation of a vehicle, the method comprising:

- monitoring a condition of a path where the vehicle is traveling, for
25 detecting an obstacle preceding the vehicle;
detecting a geometrical relationship among the vehicle, an obstacle and the path, when the obstacle is detected;
determining a steering characteristics of the vehicle, based on the geometrical relationship and the change of the geometrical
30 relationship;

determining a first possibility that the vehicle can avoid the potential collision with the obstacle by steering, based on the steering characteristics, the geometrical relationship and the change of the geometrical relationship;

- 5 determining a second possibility that the vehicle can avoid the potential collision with the obstacle by braking, based on the geometrical relationship and the change of the geometrical relationship; and

- 10 braking by a predetermined characteristics of braking operation suitable for a combined condition of the first possibility and the second possibility.